# Measuring Fuel Contamination Using Cone Penetration Testing and High Speed Gas Chromatography

Wesley L. Bratton, Ph.D. (wbratton@ara.com; 802-763-8348)
Stephen P. Farrington, P.E. (sfarring@ara.com; 802-763-8348)
Applied Research Associates, Inc.
120-A Waterman Road
South Royalton, VT 05068

Michael Akard, Ph.D. (313-662-3410)
Chromatofast, Inc.
912 Main Street, Suite 14
Ann Arbor, MI 48104

## Abstract

A Cone Penetrometer Testing/High Speed Gas Chromatography (CPT/HSGC) system has been developed to detect and quantify fuel contamination in the subsurface environment. Two CPT probes, the Dynamic Thermal Desorption (DTD) Probe and the CPT In Situ Purging (CISP) Probe, were developed to obtain gaseous phase samples from above and below the water table. An up-hole HSGC performs analysis of these samples for BTEX compounds (benzene, toluene, ethyl benzene, and xylene) in near real time. A Down-hole Trap Module (DTM) was also developed which contains three off-the-shelf adsorbent traps and can be used to retain contaminants from the gaseous samples for later desorption and analysis in a laboratory.

The DTD Probe is for use in the unsaturated zone. A heating sleeve on the DTD Probe heats the soil ahead of a sampling port as it is advanced through the ground and continuously samples air directly from the pore space of the heated soil. Heating soil adjacent to the CPT probe achieves lower detection limits per sample time by effecting thermal desorption. The heated soil gas is drawn into the probe under a slight negative pressure (provided by an up-hole vacuum pump) and then transferred to the surface via a heated PFA Teflon transfer line. The transfer line is heated to prevent sample components from condensing en route to an up-hole analyzer or traps.

The CISP Probe is for use in the saturated zone. It obtains a sample by allowing a fixed volume of groundwater to enter a stainless steel chamber in the probe through a normally closed solenoid valve. Ambient hydraulic pressure drives the flow of the sample into the probe. The sampled water is purged in situ using nitrogen to strip it of dissolved volatile organic contaminants. The purge gas is supplied by a pressurized up-hole source and returns to the surface through the heated transfer line.

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The two probes work independently and each requires exclusive use of the transfer line. Additionally, the DTM can be used behind either probe in the CPT push string to capture volatile organics from immediately downstream of the probe prior to the carrier gas passing through the transfer line.

Experiments to validate the system's capabilities were conducted in the laboratory and under controlled field conditions, as well as at a pre-characterized, fuel-contaminated site. Results were very encouraging with detection limits lower than achieved using conventional methods. Additional advantages have also initially been demonstrated for chlorinated solvents. Further development is needed to optimize the performance for other contaminants of interest.

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